Chip-Scale Heterodyne Spectrometers for Cubesats and Small Landers

Completed Technology Project (2016 - 2018)

Project Introduction

Development of chip-size remote sensors for measuring atmospheric molecules and meteorology on Earth and on other planets. We specifically target usage on future interplanetary small platforms (e.g. smallsats, small landers).

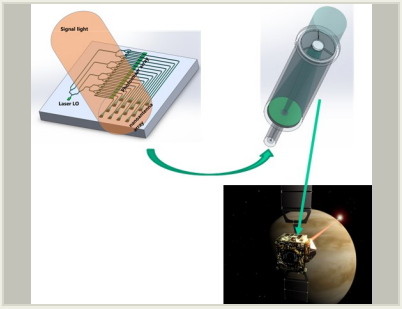
The chip spectrometer operates on the principle of heterodyne detection. Heterodyne spectrometers offer ultra-high spectral resolution, without bulky dispersive elements or moving parts, and shot-noise-limited SNR (signal-to-noise ratio). Moreover, the chip spectrometer utilizes microfabrication to produce on-chip arrays wherein each array element (pixel) is a heterodyne spectrometer. Depending on the measurement objective, these on-chip nano-spectrometers can be configured either as spatial imaging pixels to enable imaging, or as spectral pixels for increasing spectral coverage. The chip detector resides in the focal plane of a mini-telescope to detect sunlight that has propagated through the planetary atmosphere. Amplitudes of absorption lines observed in the sunlight indicate molecular abundances, while ratios between different rotational-vibrational lines indicate atmospheric temperatures. Additionally, Doppler shifts in line-center wavelengths indicate wind speeds.

Anticipated Benefits

Missions to Mars, Earth observing missions, missions to outer planets and icy satellites ("water worlds"), and missions to Venus.

This technology can provide monitoroing for crew health and safety.

DOE, EPA, NOAA: This technology can provide sensitive detection and monitoring of petrochemical leaks, greenhouse gases, and pollutants. I can also perform isotope measurements for source attribution.



This figure depicts a chip-scale heterodyne sensor array (upper left) that goes into the focal plane of a micro-telescope (upper right) to conduct atmospheric remote-sensing.

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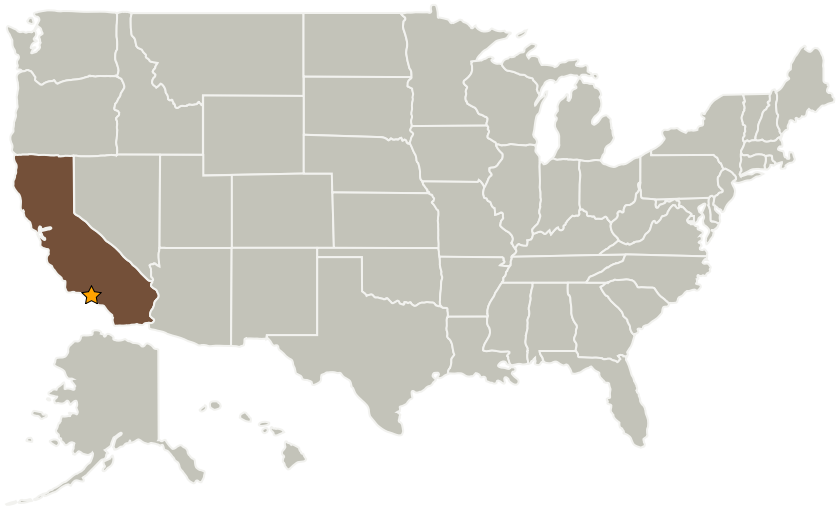
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Pin Chen

Co-Investigators:

Mahmood Bagheri
Armin Kleinboehl
Robert T Menzies
Charles D Norton
Robert L Staehle
James K Wallace
Yuk L Yung

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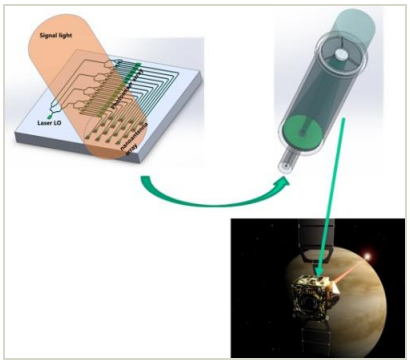
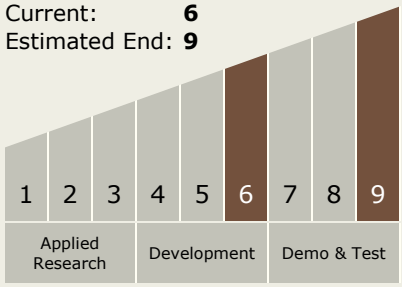
Images



JPL_IRAD_Activities Project Image
This figure depicts a chip-scale heterodyne sensor array (upper left) that goes into the focal plane of a micro-telescope (upper right) to conduct atmospheric remote-sensing.
(https://techport.nasa.gov/image/27779)

Technology Maturity (TRL)

Start: **6**
Current: **6**
Estimated End: **9**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destinations

Mars, Others Inside the Solar System, Foundational Knowledge

Supported Mission Type

Push